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USEFUL CABINET.

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ON THE NATURE OF FRICTION AND THE METHOD OF DIMINISHING ITS EFFECTS IN MACHINERY.

(Concluded.)

THE celebrated Coulomb has given the most accurate and satisfactory view of this complicated part of mechanical philosophy. By employing large bodies and ponderous weights, and conducting his experiments on a large scale, he has corrected several errors, which necessarily arose from the limited experiments of preceeding writers; he has brought to light many new and striking phenomena, and confirmed others, which were hitherto but partially established.

The following are the results, which his new and interesting experiments authorize.

1. The friction of homogeneous bodies, or bodies of the same kind moving upon one another, is generally supposed to be greater than that of heterogeneous bodies; but Coulomb has shewn that there are exceptions to this rule. He found, for example, that the friction of oak upon oak was equal to $\frac{50}{117}$ of the force of pression; the friction of pine against pine was $\frac{50}{89}$; and of oak against pine $\frac{2}{3}$. The friction of oak against copper was $\frac{2}{11}$, and that of oak against iron nearly the same.

2. It was generally supposed, that in the case of wood, the friction is greatest when the bodies are dragged contrary to the course of their fibres; but Coulomb has shown that the friction is in this case sometimes the smallest. When the bodies moved in the direction of their fibres, the friction was $\frac{50}{117}$ of the force with which they were pressed together; bnt when the motion was contrary to the course of the fibres, the friction was only^{25}.

3. The longer the rubbing surfaces remain in contact, the greater is their friction. When wood was moved upon wood, according to the direction of the fibres, the friction was increased by keeping the surfaces in contact for a few seconds; and when the time was prolonged to a minute, the friction seemed to have reached its farthest limit. But when the motion was performed contrary to the course of the fibres, a greater time was necessary before the friction arrived at its maximum. When wood was

moved upon metal, the friction did not attain its maximum till the surfaces continued in contact for 5 or 6 days; and it is very remarkable, that when wooden surfaces were anointed with tallow, the time requisite for producing the greatest quantity of friction is increased. The increase of friction, which is generated by prolonging the time of contact, is so great, that a body weighing 1650 pounds was moved with a force of 64 pounds when first laid upon its corresponding surface. After having remained in contact for the space of 3 seconds, it required 160 pounds to put it in motion, and when the time was prolonged to 6 days, it could scarcely be moved with a force of 622 pounds. When the surfaces of metallic bodies were moved upon one another, the time of producing a maximum of friction was not changed by the interposition of olive oil; it was increased, however, by employing swine's grease as an unguent, and was prolonged to 5 or 6 days by smearing the surfaces with tallow.

4. Friction is in general proportional to the force, with which the rubbing surfaces are pressed together; and is, for the most part, equal to between $\frac{1}{2}$ and $\frac{1}{4}$ of that force.—In order to prove the first part of this proposition, Coulomb employed a large piece of wood, whose surface contained 3 square feet, and loaded it successively with 74 pounds, 874 pounds, and 2474 pounds.—In these cases the friction was successively $\frac{50}{123}$ $\frac{25}{54}$ $\frac{100}{221}$ of the force of pression; and when a less surface and other weights were used, the friction was $\frac{25}{59}$ $\frac{50}{121}$ $\frac{25}{60}$. Similar results were obtained in all Coulomb's experiments, even when metallic surfaces were employed. The second part of the proposition has also been established by Coulomb. He found that the greatest friction takes place when oak moves upon pine, and that it amounts to $\frac{50}{89}$ of the force of pression; on the contrary, when iron moves upon brass, the least friction is produced, and it amounts to $\frac{1}{4}$ of the force of pression.

5. Friction is in general not increased by augmenting the rubbing surfaces.—When a superficies of 3 feet square was employed, the friction, with different weights, was $\frac{25}{37}$ at a medium; but, when a smaller surface was used, the friction instead of being greater, as might have been expected, was only $\frac{100}{239}$.

6. Friction, for the most part, is not augmented by an increase of velocity. In some cases, indeed, it is diminished.—M. Coulomb found, that when wood moved upon wood in the direction of the fibres, the friction was a constant quantity, however much the velocity was varied; but that when the surfaces were very small in respect to the force with which they were pressed, *the friction was diminished by augmenting the rapidity*: the friction, on the contrary, was increased when the surfaces were

very large when compared with the force of pression. When the wood was moved contrary to the direction of its fibres, the friction in every case remained the same. If wood is moved upon metals, the friction is greatly increased by an increase of velocity; and when metals move upon wood, smeared with tallow, the friction is still augmented by adding to the velocity.—When metals move upon metals, the friction is always a constant quantity; but when heterogeneous substances are employed, which are not daubed with tallow, the friction is so increased with the velocity, as to form an arithmetical progression when the velocities form a geometrical one.

7. The friction of loaded cylinders, rolling upon a horizontal plane, is in the direct ratio of their weights, and the inverse ratio of their diameters. In Coulomb's experiments, the friction of cylinders of guaiacum-wood, which were two inches in diameter, and were loaded with 1000 pounds, was 18 pounds or $\frac{1}{56}$ of the force of pression. In cylinders of elm, the friction was greater by $\frac{2}{3}$, and was scarcely diminished by the interposition of tallow.

From a variety of experiments on the friction of the axis of pullies, Coulomb obtained the following results.—When an iron axes moved in a brass bush or bed, the friction was $\frac{1}{6}$ of the pression; but when the bush was smeared with very clean tallow, the friction was only $\frac{1}{11}$; when swines grease was interposed, the friction amounted to $\frac{2}{11}$; and when olive oil was employed as an unguent, the friction was never less than $\frac{1}{8}$ or $\frac{2}{15}$. When the axis was of green oak, and the bush of guaiacum-wood, the friction was $\frac{1}{26}$ when tallow was interposed; but when the tallow was removed, so that a small quantity of grease only covered the surface, the friction was increased to $\frac{1}{11}$. When the bush was made of elm, the friction was in similar circumstances $\frac{1}{33}$ and $\frac{1}{20}$, which is the least of all. If the axis be made of box, and the bush of guaiacum wood, the friction was $\frac{1}{23}$ and $\frac{1}{14}$, circumstances being the same as before. If the axis be of box-wood, and the bush of elm, the friction will be $\frac{1}{23}$ and $\frac{1}{20}$; and if the axis be of iron and the bush of elm, the friction will be $\frac{1}{20}$ of the force of pression.

Having thus considered the origin, the nature, and the effects of friction, we shall now attend to the method of lessening the resistance, which it opposes to machinery. The most efficacious mode of accomplishing this is to convert that species of friction, which arises from one body being dragged over another, into that which is occasioned by one body rolling upon another. As this will always diminish the resistance, it may be easily effected by applying wheels or rollers to the sockets or bushes, which sus-

tain the gudgeons of large wheels, and the axes of wheel-carriages. Casatus seems to have been the first, who recommended this apparatus. It was afterwards mentioned by Sturmius and Wolfius; but was not used in practice till Sully applied it to clocks in the year 1716, and Mondran to cranes in 1725. Notwithstanding these solitary attempts to introduce friction-wheels, they seem to have attracted but little attention till the celebrated Euler examined and explained, with his usual accuracy, their nature and advantages. The diameter of the gudgeons and pivots should be made as small as the weight of the wheel and the impelling force will permit. The gudgeons should rest upon two wheels as large as circumstances will allow, having their axes as near each other as possible, but no thicker than what is absolutely necessary to sustain the superincumbent weight. When these precautions are properly attended to, the resistance, which arises from the friction of the gudgeons, &c. will be extremely trifling.

The effects of friction may likewise in some measure be removed by a judicious application of the impelling power, and by proportioning the size of the friction-wheels to the pressure, which they severally sustain. If we suppose, for example, that the weight of a wheel, whose iron gudgeons move in bushes of brass, is 100 pound; then the friction arising from both its gudgeons will be equivalent to 25 pounds. If we suppose also that a force equal to 40 pounds is employed to impel the wheel, and acts in the direction of gravity, as in the case of overshot wheels, the pressure of the gudgeons upon their supports will thus be 140 pounds and the friction 35 pounds. But if the force of 40 pounds could be applied in such a manner as to act in direct opposition to the wheel's weight, the pressure of the gudgeons upon their supports would be 100—40 or 60 pounds, and the friction only 15 pounds. It is impossible indeed to make the moving force act in direct opposition to the gravity of the wheel in the case of water-mills; and it is often impracticable for the engineer to apply the impelling power but in a given way; but there are many cases, in which the moving force may be so exerted, as at least not to increase the friction, which arises from the wheel's weight.

When the moving force is not exerted in a perpendicular direction, but obliquely, as in undershot wheels, the gudgeon will press with greater force on one part of the socket, than on any other part. This point will evidently be on the side of the bush oposite to that where the power is applied, and its distance from the lowest point of the socket, which is supposed circular and concentric with the gudgeon, being called x we will have

Tang. $x = \frac{H}{V}$ that is, the tangent of the arch contained between the point of greatest pressure and the lowest point of the bush, is equal to the sum of all the horizontal forces, divided by the sum of all the vertical forces and the weight of the wheel; H representing the former, and V the latter quantities. The point of greatest pressure being thus determined, the gudgeon must be supported at that part by the largest friction-wheel, in order to equalize the friction upon their axes.

The application of these general principles to particular cases is so simple as not to require any illustration. To aid the conceptions, however, of the practical mechanic, we may mention two cases in which friction-wheels have been successfully employed.

Mr. Gottlieb, the constructor of a new crane, has received a patent for what he calls an anti-attrition axle tree, the beneficial effects of which he has ascertained by a variety of trials. It consists of a steel roller about 4 or 6 inches long, which turns within a groove cut in the inferior part of the axis. When wheel-carriages are at rest, Mr. Gottlieb has given the friction wheel its proper position; but it is evident that the point of greatest pressure will change when they are put in motion, and will be nearer the front of the carriage. This point, however, will vary with the weight of the load; but it is sufficiently obvious that the friction-roller should be at a little distance from the lowest point of the axle-tree.

Mr. Garnett of Bristol has applied friction-rollers in a different manner, which does not, like the preceding method, weaken the axle-tree. Instead of fixing the rollers in the iron part of the axis, he leaves a space between the nave and the axis to be filled with equal rollers almost touching each other. The axes of these rollers are inserted in a circular ring at each end of the nave, and these rings, and consequently the rollers are kept separate and parallel, by means of small bolts passing between the rollers from one side of the nave to the other.

In wheel-carriages constructed in the common manner with conical rims, there is a great degree of resistance occasioned by the friction of the linch-pins on the external part of the nave, which the ingenious mechanic may easily remove by a judicious application of the preceding principles.

As it appears from the experiments of Ferguson and Coulomb, that the least friction is generated when polished iron moves upon brass, the gudgeons and pivots of wheels, and the axes of friction-rollers, should all be made of polished iron, and the bushes, in which these gudgeons move, and the friction-wheels, should be formed of polished brass.

M. de La Hire recommends the sockets or bushes to be made square and not concave.

When every mechanical contrivance has been adopted for diminishing the obstruction, which arises from the attrition of the communicating parts, it may be still farther removed by the judicious application of unguents. The most proper for this purpose are swines grease and tallow, when the surfaces are made of wood; and oil, when they are of metal. When the force, with which the surfaces are pressed together, is very great, tallow will diminish the friction more than swines grease. When the wooden surfaces are very small, unguents will lessen their friction a little, but it will be greatly diminished if wood moves upon metal greased with tallow. If the velocities, however, be increased, or the unguent not often enough renewed, in both these cases, but particularly in the last, the unguent will be more injurious than useful. The best mode of applying it, is to cover the rubbing surfaces with as thin a stratum as possible, for the friction will then be a constant quantity, and will not be increased by an augmentation of velocity.

In small works of wood, the interposition of the powder of black lead has been found very useful in relieving the motion. The ropes of pulleys should be rubbed with tallow, and whenever the screw is used, the square threads should be preferred.

COMMUNICATION, ON AMERICAN GENIUS.

MESSRS EDITORS,

Notwithstanding the declarations frequently made by foreigners against the originality or importance of the inventions of *Native Americans*; perhaps it is true, that no country, in proportion to its population, has produced a greater number of inventions and improvements useful in the common coucerns of life, than the United States since the establishment of the national constitution. Yet it must not be denied that America has granted patents for objects of small importance, but this necessary result from a general system is not a sufficient argument against the beneficial effects of a patent law in a country, where wealth is increased in proportion to the increase of the productive labor of its inhabitants.

By the constitution of the society, to which you belong, it is declared to be an essential duty to aid inventive genius in honourable pursuits and to encourage and direct it to such useful studies, as tend to the greatest convenience of Society. It may be expected that the USEFUL CABINET, as far as its influ-

ence extends, will *discourage* frivolous pretensions to the monopoly of trivial objects, and thereby diminish the antipathy, which many people indulge against patents.

It will afford satisfaction to the considerate part of your readers to find, when you give a plate or description of any patented invention, that you add a correct account of the extent, to which such invention has been carried in general use, of the approbation it has obtained from judicious persons, and the defects, which may be capable of further amendment, (so far as is within your knowledge.)

Another subject may deserve your attention, which is, that machines and inventions, highly valuable and capable of producing incalculable benefits to the nation, are brought to such a degree of perfection, as just to evince their importance, and then die away from public knowledge. This last consideration is suggested from a recollection of seeing some years since on board of a small vessel at the Boston pier, a *Machine for making Shingles*, which raised the highest expectations, in all who saw it of being very useful to the country in furnishing a well made article of the first importance for home use, and forms a valuable export to the West Indies.

It would be gratifying to receive information, why the public have not been benefited, as might be expected, from so valuable an invention. If the inventors progress was impeded by indigence, it is much to be regretted. The shingles made in that machine (as was judged by the samples then shewn, some of which were cross grained and curly, yet all well shaved, and of even thickness and regular taper,) were so superior to the generality of trash sold here under that name, that a wealthy mill-owner, in a country abounding with suitable timber, might benefit himself and the patentee, by aiding to establish an extensive manufacture of so necessary an article. W

ON INVENTION.

MESSRS. EDITORS.

IT has been frequently observed, with seeming propriety, that America has progressed more rapidly in mechanical, than in scientific improvements. But it is not to be inferred from hence, that the great mass of people are deficient in ordinary learning. It is in celebrity of science, where she cannot compare with nations more enlightened. Her wishes are to equal others; yea, to excel them; but it is vain to repose on that pleasing hope,

until views more just shall regulate the passion of the age, and true greatness become the standard of glory. Independent America, excited by necessity, and stimulated by her enterprising turn, has sought with such avidity the accumulation of riches, and the luxuries of life, as to afford herself but little time to loiter on the banks of Avon. The stream of science has not become her favorite beverage. Self interest is so deeply rooted, that wealth is considered the first qualification of honor; hence virtue receives not her due meed of praise, erudition comes short of her merited patronage, and charity is confined in the iron chains of cursed avarice.

"Even wonted friendship turns to cold neglect,
"Where wealth is made the standard of respect."

America has, by her industry, within a span of years, transformed an immense wilderness into cultivated fields. Her sons have traversed all oceans, and explored all climes, for a market for her produce. In simplicity of structure, and expertness of operation in mechanical inventions, she has, in some instances, surpassed the old world. Yet her spirit of invention has often been repugnant to theory; and what has been gained by successful industry, has sometimes been lost by unsuccessful experiments. Much has been spent in fruitless efforts to give self moving power to inert matter. Might we not as well attempt, by the force of imagination, to bring an image of the mind into corporeal existence? Would not the rotary and annual motions of this globe cease, were it destitute of the continued agency of the governing Intelligence?—Inanimate bodies receive motion from some active power; such motion retarded by gravitation, and the resisting medium, cannot continue but by a ceaseless efficiency. This axiom has received the sanction of experience through ages, it is therefore futile to expect perpetual motion to be produced by finite power. Let us, therefore, calculate within the bounds of probability, and make usefulness the object of our labours. Much may be saved by a thorough investigation of principles, previous to execution; without which, many impracticable things have been attempted, and many of importance abandoned. Where greater power is required to overcome great resistance, how often do we err in calculation! In respect to strength of parts, how often do we greatly err in complication of system! Too frequently has the most fanciful clock work been concatenated, which, though it may have accomplished the object, became useless on account of requisite repairs; the expences of which would render it unprofitable, or

from the want of artists capable of making them. *Simplicity, correctness,* and *dispatch* constitute the value of all machines. Any machine, which diminishes manual labour in the facture of useful articles, is an important acquisition ; especially in a country possessed of a rich, extensive, and uncultivated soil. For, as the real wealth of a nation consists in soil, population, and industry, a diminution of labour, by machinery, adds to the national interest, in proportion as it increases the number of laborers who may be profitably employed in agriculture.

O. D.

IN this number we present our readers with a plate and description of a new invented TOOTH EXTRACTOR. We have seen the instrument, and have had the opinion of several judges, that it is superior to any former invention.* The principles and description of its construction, with some professional observations, are published as communicated by the inventor, at the request of

THE EDITORS.

To the Editors of the Useful Cabinet.

GENTLEMEN,

HAVING invented an Instrument of a peculiar and novel construction for extracting teeth, and being convinced by repeated successful experiments, that its new properties give it superiority to any other Instrument, with which I have operated, duty actuates me to exhibit it to public view. I therefore inclose you as accurate a drawing of it as I can procure, with a few explanatory references. Should you think this explanation worth inserting in the USEFUL CABINET, it is at your service,

Yours, &c,

JOHN DWIGHT.

THE several parts of this Instrument are so constructed, and concatenated in such a manner, that it is very difficult to give the examiner a correct understanding of it by an entire figure. The Painter has, therefore, the better to explain the thing, not only given a representation of the Instrument entire ; but of each of its parts seperate, as well as a section of such parts combined as were deemed to be most proper to afford clear ideas of its construction, mode of operation, and of its powers.

* *We understand the Inventor will soon have instruments on hand to supply those who may want them.*

Explanatory References.

A Represents the *Fulcrum* or *Bolster*, measuring about $\frac{7}{8}$ of an inch logitudinally, and about $\frac{1}{2}$ of an inch in breadth, with a foramen at the bottom, which receives the shank.

B Represents the *Slide*, which moves longitudinally in the Bolster; it is about $\frac{6}{8}$ of an inch long, $\frac{3}{16}$ wide, and nearly the same in thickness; it is dentated at each end, but on opposite sides.

C Represents the *Claw*, not much unlike the common claw, except the end which is connected with the Bolster, which behind the pivot, next the slide, has two teeth fitting those in the upper end of the slide.

D Represents the *Bolster*, *Slide*, and *Claw* connected, and in such a position as to exhibit one end of the slide behind the top of the Bolster, while a tooth on the other end is seen in the foramen at the bottom of the Bolster.

E Represents a Section of the last mentioned part, with a diseased tooth between the Bolster and Claw, for the purpose of shewing the motions and powers of the several parts of the Instrument.

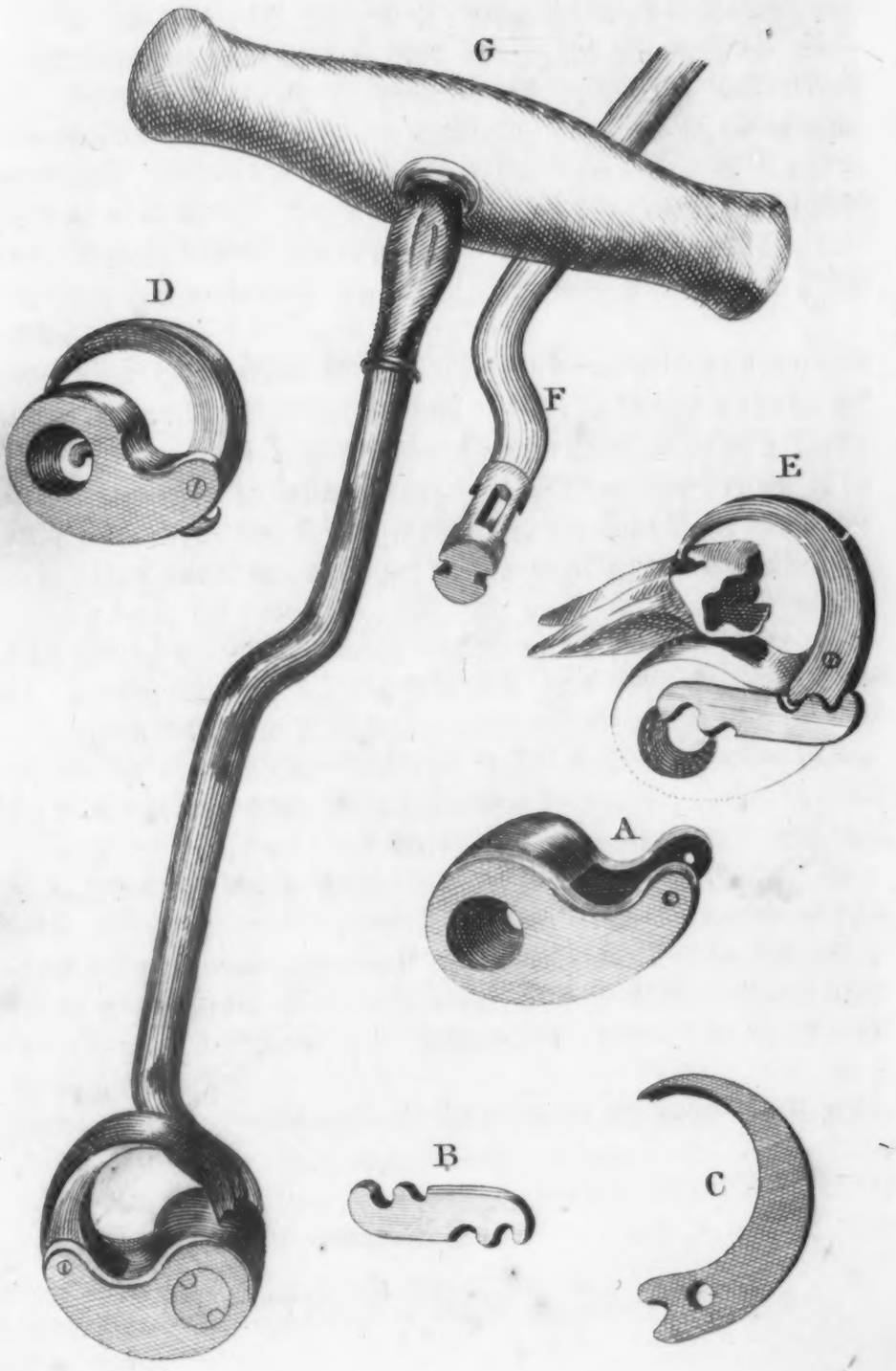
F Represents that portion of the *Shank* which is fitted to play in the foramen of the Bolster; on which end it has two pinions fitting the teeth on the lower end of the slide.

This Shank is so fitted with its pinions that it enters the Bolster on either side, which prepares the Instrument for extracting teeth from opposite sides of the jaw.

G Represents the entire Instrument with as many of its parts as can be exhibited from one view.

By the above mentioned mechanism, powers are obtained, of which other Instruments fall short. It enables the operator to fix the claw to the tooth, previous to an attempt to extract, with that degree of required firmness, which shall prevent the claw from slipping off; hence he has the power of raising the tooth in the best possible degree of approximation to perpendicularity.* Could an instrument be constructed in such a manner, that it would always extract the tooth exactly perpendicular, we should loose by it more than we should gain. For where the prongs of a tooth are much diverging, or converging so as to embrace portions of bone, what power, without doing violence, could raise the tooth perpendicularly? relinquishing any farther attempt to point out the properties of this Instument, or to compare it with others, I do, with the few imperfect observations herein made, submit it to the candour of niee operators, after they shall have proved it, to judge of its merits or demerits.

* Mr. Reece, attempted this by an incommodious spring fixed on the top of the Fulcrum.



Wightman Sc

It is much to be lamented, that the operation of tooth-drawing is deemed by so great a class of the people of so little importance as to be left to the practice of those both ignorant of the art, as well as the structure of the parts; yet notwithstanding, the frequent occurrences of violence and error, on account of their rude and unscientific mode of proceeding, patients will trust themselves under their hands. I conceive it often to be a nice point in surgery to determine whether the extraction of a tooth be absolutely necessary. Many applications for extraction have been made to me, where by removing scales of tartar from the teeth, the pain immediately ceased, and the teeth remained firm in the jaws.

On the other hand most serious effects have taken place by omitting, or delaying the extraction. One instance mentioned here may suffice. "A case occurred some time since of a Lady "who fell a sacrifice to inflamation arising from the irritation of "a tooth. Soon after she found it painful, she sent for a Surgeon "to extract it, which, on account of the contiguous parts being "much inflamed, he postponed till the next morning, recom- "mending in the interim, proper means to be taken for its reso- "lution. In the course of the night it had unfortunately in- "creased, which on the following morning rendered the opera- "tion more objectionable. On the third morning, the infla- "mation had extended to the œsophagus and neck, so as to pre- "vent deglutition; and on the fifth, it had spread to the breasts, "which were amazingly tumefied. About the ninth, a very "extensive suppuration took place. About the eleventh it as- "sumed a gangrenous appearance, which soon terminated in "mortification, in spite of the efforts of her medical attendants, "who are deservedly esteemed Gentlemen of great professional "judgment and skill."

Might not this Lady have lived had the tooth been extracted when the Surgeon was first called?

QUESTIONS ANSWERED.

MESSRS EDITORS,

THE 3d. mathematical question like the 1st. in the series, seemed to be designed by your *pupil*, merely an introduction to that which follows, it is as evident as the 1st. and depends on some of the first principles in Euclid, but as the 4th is very important, the same method of considering them is submitted by

H—w.

3d. *Question*, MECHANICALLY, (see page 42.)

1st. By a rule, measure on the leg A C, any distance from D, which note, then on the leg A B, the same distance from D, which note, draw a line from one point to the other, which will be the line required.

2d. By the square, place the leg of the square at the point D, with the angle of the square between the legs of the given angle, draw a line by the arm of the square from one of the legs of the angle, and produce it till it terminates in the other leg.

3d. By the dividers, with one foot in D, draw a circle cutting both the legs of the given angle, and by a rule draw a line, which shall connect the points where the circle intersects the legs, which will be the line required.

4th Question, MECHANICALLY.

1st. By the square,* the extremities of that circle on the arm of the square, whose diameter is equal to the given line, being placed in the legs of the angle, while the inner line of the leg of the square is kept on the point D, draw a line by the arm of the square terminating in the sides of the angle, which will be the line required. By this instrument surveyors and draughtsmen may draw plans, as correctly, as the same question can be done by any other instrument.

2d. By the rule and dividers, at any point in the leg of the angle A C, near to A, with the foot of the dividers in D, draw a circle cutting the legs of the angle, from the points of intersection in one leg, draw a line to the point of intersection in the other leg, from the center of which line draw a line to the point D, which will be at right angles, then produce the line on each side equal to half the given line E F, which may fall *without* the legs of the angle. Then at any greater distance from D, on the leg A C, as at C, with the foot in D, draw another circle cutting the legs of the angle, and from the center of the segment draw a line to the point D; with the rule laid across the points of intersection of the legs, on each side the line drawn to the point D, between the points of intersection, draw a line equal to half the given line E F. which will terminate *within* the legs of the given angle.

By this process it is evident that a greater and a less line than the given line, can be made within the legs of the angle,

* The double square, or *mathematical square*, may have concentric circles on the arm, drawn from the point where the line continued from the inner side of the leg, intersects the outer line of the arm, which point, for distinction, may be called *the index*.

and with the limitation prescribed in the proposition, but by the mathematical square the required line is found with as much accuracy, as these are found, which do not comport with the requirements, and it is evident that such a line can have place as required, although the manner of finding such place by rule and dividers is not yet disclosed, and perhaps may never be discovered.

As this may be a question of consequence in the construction of a diagram, by which some important discovery may be demonstrated, some opinions from the most approved editors of Euclids Elements are subjoined.

Dr. Robert Simpson professor of mathematics, in the University of Glasgow, in his notes page 357 * observes, "that in the demonstration of theorems, it is sufficient, in this and the like cases, that a thing made use of in the reasoning can possibly exist, providing this be evident, though it cannot be exhibited or found by a geometrical construction: So, in this place, it is assumed, that there may be a fourth proportional to these three magnitudes, viz. the squares of BD, FH, and the circle ABCD; because it is evident that there is some square equal to the circle ABCD though it cannot be found geometrically &c."

See also page 301. that the number of axioms ought not to be encreased without necessity, &c.

Also pages 302 and 303. concerning the words postulate, and axiom.

Also page 308. where he says. "Several authors, especially among the modern mathematicians and logicians, inveigh too severely against indirect or apagogic demonstrations, and sometimes ignorantly enough; not being aware that there are some things that cannot be demonstrated any other way."

Also page 348. quotation from Thomas Simpson.

John Playfair, F. R. S. professor of mathematics in the University of Edinburgh, in his preface in the 9th, 10th and 14th pages, observes at large on the rigid rule of geometrical reasoning.†

F. Nichols the learned and correct Editor of the Philadelphia edition of Playfair's geometry has corrected some errors and abridged the preface, but has preserved what is referred to above, as follows:

"With respect to the Geometry of Solids, in the Third Book, I have departed from Euclid altogether, with a view of rendering it both shorter and more comprehensive. This, however, is not

* Eighth Edinburgh Edition.

† Edinburgh second Edition.

attempted by introducing a mode of reasoning less rigorous than that of the Greek geometer; for this would be to pay too dear even for the time that might thereby be saved; but it is done chiefly by laying aside a certain rule, which, though it be not essential to the accuracy of demonstration, Euclid has thought it proper, as much as possible, to observe."

"This rule influences the arrangement of his propositions through the whole of the Elements. In the demonstration of a theorem he never supposes any thing to be done, as any line to be drawn, or any figure to be constructed, the manner of doing which he has not previously explained. Now the only use of this rule is to prevent the admission of impossible or contradictory suppositions, which, no doubt, might lead into error; and it is a rule well calculated to answer that end, as it does not allow the existence of any thing to be supposed, unless the thing itself be actually exhibited. But it is not always necessary to make use of this defence; for the existence of any thing is obviously possible, and very far from implying a contradiction, where the method of actually exhibiting them may be altogether unknown. Thus, it is plain that on any given figure as a base, a solid may be constituted, or conceived to exist, equal to a given solid, and yet it may, in many cases, be a problem of extreme difficulty to assign the height of such a solid, and actually to exhibit it.—And therefore to follow, as Euclid has done, the rule that excludes this, and such like hypotheses, is to create artificial difficulties, and to embarrass geometrical investigation with more obstacles than the nature of things has thrown in its way. This is a rule, too, which cannot always be followed, and from which even Euclid himself has been forced to depart in more than one instance."

"In a Book on the Properties of Solids, which I now offer to the public, I have not sought to subject the demonstrations to the law just mentioned, and have never hesitated to admit the existence of such solids, or such lines as are evidently possible, though the manner of actually describing them may not have been explained."

Mr. Nichols in his advertisement to the American edition, which is well worthy of attentive perusal, makes the following observations, viz. "An elementary treatise of geometry is supposed to exhibit a perfect model of logical argumentation."

Again, "a selection from Playfair's Notes on the Elements has been made, and those, which would be entirely useless to the reader are omitted.

But no alterations have been made by the publisher without the advice and approbation of certain professors of mathematics."

In his note on the 8th. prop. Book I. after his demonstration he observes. "Such demonstrations, it must, however, be acknowledged, trespass against a rule, which Euclid has uniformly adhered to throughout the Elements, except where he was forced by necessity to depart from it. This rule is, that nothing is ever supposed to be done, the manner of doing which has not been already taught, and the construction derived either directly from the postulates laid down in the beginning, or from some problems already reduced to those postulates. Now this rule is not essential to geometrical demonstration, where, for the purpose of discovering the properties of the figures, we are certainly at liberty to suppose any figure to be constructed, or any line to be drawn, the existence of which does not involve an impossibility."

We shall close these quotations with an extract from Alexander Ingram's Elements of Euolid published at Edinburgh in 1799, in his notes on Book I. page 230.

"As to axioms, it is generally allowed, that they ought to be self-evident, and likewise as few as possible ; for nothing ought to be considered as self-evident that is capable of demonstration.

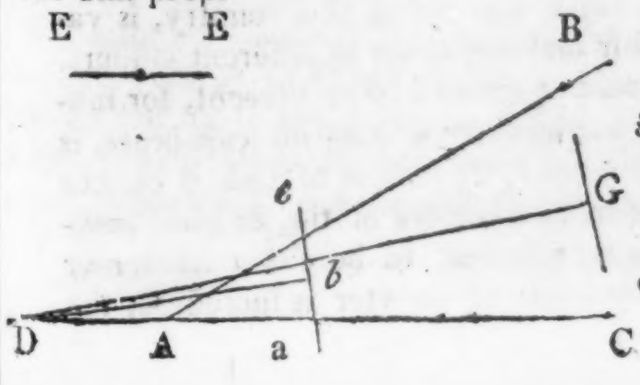
The postulates ought likewise to be as few as possible ; for, as Sir Isaac Newton observes, postulates are principles, which geometry borrows from the arts, and its excellence consists in the paucity of them. The postulates of Euclid are all problems derived from the mechanics ; but there are things assumed by geometers, which are neither self-evident nor problems.

Many moderns maintain, that we are at liberty to assume any thing, the existance of which does not imply a contradiction, or involve an impossibility.

It is necessity, and not liberty, which is the cause of assumptions.

It follows from this, that assumptions ought to be as particular as possible ; for example, we ought not to assume a general proposition, if it can be demonstrated by assuming a particular case of it."

With these authorities in view, we proceed to consider the propositions geometrically. The third being evident we pass to the 4th. prop.



i. e. In the angle B A C, can a line be drawn terminating in the lines C, A,—B A, which shall be equal to E F, and at right angles with a line from its center to the point D.

CONSTRUCTION.

In the leg A C, take A a, equal to D A, and with the radius D A, draw a circle intersecting the legs of the given angle, draw a chord from one point of intersection to the other, and from the center draw the line e D, then from e extend e b, and e a, equal to half E F, then will a b, be equal to E F.

Take C a, equal to D a, and with the radius D C, draw a circle intersecting the legs of the given angle at the points C B, bisect the segment of the circle and from the center draw the line G D,—by a parallel on each side of G D, distant therefrom equal to half E F, and continued to intersect the segment C G B, from the points where the parallels intersect the segment draw a line c g, which will be equal to E F.—draw the lines b g, and a c, intersecting the legs of the angle, and from those points of intersection draw a line terminating in the side of the angle, and equal to the given line.

A premium of 12 numbers is offered by the Editors of the Useful Cabinet, monthly as published, or handsomely bound in one volume at the end of the year; for a correct demonstration, or the best geometrical solution of this 4th question or proposition, with the aid here furnished.

Also the like premium for the best answer to a request in the January number for a *Luting for Stove Joints.* To be sent in to the printer by the 1st. of May next, sealed and directed to the Editors.

MAKING BRASS.

MESSRS EDITORS,

AS the process for making of brass from copper and zink, equal to that which is made from the same materials in Europe, is so little known in America, I presume a communication on this subject will not be unacceptable. The composition which is used by those, who understand this art in this country, is various, and is also different for making brass of different colours. The composition, which is most approved of at present, for making brass of the colour and malleability of English cast brass, is as follows: viz. 8 pounds of copper, $2\frac{1}{2}$ pounds of zink, 6 ounces of lead, and from one ounce to two ounces of tin, or good pewter; according as the brass is required to be either harder or softer. The more the proportion of pewter is increased, the

harder and paler the brass will be; but the proportion of lead must by no means be *decreased*, if the brass is to be turned, or filed, as it will clog the file, and cannot be turned smooth. If the brass is not to be soldered, one third part more of lead may be added, which will cause the metal to be worked easier, and will not impair the colour of the brass, as is the case with pewter; consequently, if the brass is to be made of a paler colour, the proportion of pewter must be increased, and that of lead and zink diminished.

The process for melting the materials together is as follows:—$\frac{2}{3}$ of the copper must be first melted in a crucible sufficiently large to contain all the materials, and the heat raised to that degree, that will effectually fuse them—then first put in the lead and pewter; then the zink in a solid state, (for if the zink be first melted and poured in, it will detonate and a great part will be lost) then add the remainder of the copper; and when the whole is melted stir the metal in the crucible and increase the heat to the degree required for casting the brass.—The metal must be stirred again previous to pouring it into the moulds—The quicker the requisite degree of heat for casting is given to the metal after the last portion of copper is added, the less the zink will evaporate, and the finer the brass will be.

A. E.

Method of preserving Eggs, for one, two, or more years, which may be serviceable to passengers on long voyages, as well as for domestic use.

Take of Quick Lime 1 bushel,
Bay Salt 32 ounces,
Cream of Tartar 8 do.
} or a less quantity of each, observing the due proportion,

these mix together, with as much water as will render the composition, or mixture, of that consistence that an egg put therein will swim; and its top appear just above the surface of the liquid; into which put and keep the eggs, which will preserve them perfectly sound for two years at least.

In addition to the above, it is recommended, that a board, or follower, made to fit the vessel in which the eggs are kept, be put on the top to keep them below the surface of the liquid. Eggs, which were put into pickle of this kind eighteen months since, were used since the commencement of this year.

ORIGIN OF ARTS.

(Continued from page 31.)

THE invention of globes and maps is ascribed by historians to Anaximander of Miletus in Asia Minor, who flourished about 550 years B. C. By the assistance of these, in connection with his own correct observations, he endeavoured to prove, from principles of analogy and from the invariable laws of motion, the sphericity, rotation, and revolution of the Earth ; and its similarity to the other planets of the solar system. Unfortunately, the ignorance and bigoted incredulity of that, as well as many succeeding ages, prevented, for two thousand years, the introduction of the correct doctrine of the spheres. The ideas he entertained of the solar system, as expressed by the construction of his globes, were undoubtedly of service to succeeding philosophers, who, improving upon the notions of their predecessors, furnished the great Sir Isaac Newton with such data as to enable him, at the beginning of the eighteenth century, to demonstrate the solar system upon its true principles.

The advantages derived from globes and maps in the study of astronomy, geography, and navigation are very great.

Adams's globes—London—at the present day are executed in the most correct and elegant manner. The same may, with truth, be said of Arrowsmith's maps—London. American artists however are not far behind in the production of the latter. The maps of several of the states of America, taken from actual survey by order of their respective governments, are really an honor to the country.

Every school and Academy ought to be furnished with a good set of maps at least, and with a set of globes when the institution is of sufficient importance. With their assistance, under the care of an intelligent master, scholars would acquire more correct knowledge of geography in one month, than they could in a year's study without them.

To Pythagoras, one of the most wise and learned of the Grecians, who flourished about 500 years B. C. the world is indebted for the demonstration of the 47th proposition in Euclid's elements of geometry, viz. that the sums of the squares of the two legs of a right angled triangle are equal to the square of the base or longest line. The importance of this correct maxim in surveying, navigation, trigonometry, mensuration of heights and distances, and in astronomical calculations, is very great. The architect and carpenter find much assistance from a knowledge of this rule as applied in their occupations. Besides this discovery, Pythagoras produced many more both in natural philosophy,

and in the mechanic and liberal arts. His system of the universe corresponds exactly with that demonstrated by the great Sir Isaac Newton.

As his learning and genius produced the most astonishing effects among his countrymen, in prompting the idle and vicious to habits of industry and morality; and as the Greeks thereby, as well as the neighbouring nations, became famous for their learning and skill in the mechanical arts, it is presumed, a short digression to give an historical sketch of this great man, whom the ancients justly styled the "father of human wisdom," will not be unacceptable.

Pythagoras first made himself known in Greece at the Olympic Games, where in his eighteenth year he obtained the prize. Here he was universally admired for the elegance and dignity of his person, and for the brilliancy and powers of his mind.—From Olympia he retired into the east. In Egypt and Caldæa he gained the confidence of the priests, and learned of them the artful policy, and symbolic writings, by which they governed the princes as well as the people. Having spent many years in gathering all the information, which could be collected from autique tradition, he returned to SAMOS, his native island. Here the tyranny of Polycrates disgusted the philosopher, who was a great advocate for national independence, and, though the favorite of the tyrant, he left the island, and a second time attended the Olympic Games. His fame was too well known to escape notice. In that assembly he was saluted by the appellation of the "*wise man.*" This he refused, and declared himself satisfied with that of the "philosopher" or "*friend of wisdom.*" In explanation of this new and modest appellation he was contented to have given him, he observed: "That, to the Olympic games, some were attracted with the desire of obtaining crowns and honors; others came to expose their different commodities to sale; while curiosity, and the desire of contemplating whatever deserves notice in that celebrated assembly, drew a third class.—Thus on the more extensive theatre of the world, while many struggle for the glory of a name, and many pant for the advantages of fortune, a few, and indeed but a few, who are neither desirous of money, nor ambitious of fame, are sufficiently gratified to be spectators of the hurry, the wonder, and magnificence of the scene."

From Olympia he retired to Magna Græca, where he fixed his habitation, in the 40th year of his age. Here he founded a sect in moral philosophy denominated *the Italian*; and he soon saw himself surrounded by a great number of pupils, whom the fame of his mental, as well as personal accompslhments, had

attracted. His skill in medicine, and music, his knowledge in mechanics, mathematics, and natural philosophy gained him friends and admirers.

The most debauched and effeminate were pleased with the eloquence and genius of the philosopher, who boldly upbraided them for their vices, and called them to more virtuous and manly pursuits. He maintained that every occupation, whether scientifical, mechanical, commercial, or agricultural, by which the comforts and conveniences of human life were equally promoted, was in itself praise-worthy and honourable. That of the several branches of business, there was none, that afforded such opportunities for the exercise and disclosure of the genius and wisdom of the human mind, as mechanics. In these its creative and inventive powers are frequently displayed, to the admiration of the world, and to the great advantage of mankind. Success in war, and prosperity in peace depend on the artificial powers produced by mechanics. A nation is *independent* only in proportion to their *ability of producing* and manufacturing those articles, which either their *necessity* or conveniency may require.

Industry, he considered, to be the mother of many virtues, but idleness the siren-patroness of crimes and wretchedness. The greatest misfortune, he believed, that could befall a man of understanding, would be the loss of his reputation for honesty, veracity, and integrity. Next to these, punctuality in the performance of promises, was in his estimation, an important virtue, the strict observance of which frequently gained a man both fortune and friends. Indeed, without these virtues, man was but an enemy to his race, and disgraced an existence, which was given him to honor and to render happy in this world, in order that he may enjoy greater happiness in the next among the immortal gods.

These animated sentiments delivered by a man, whose aspect was fascinating and venerable, whose voice was harmonious, whose eloquence was considered divine, added to the reputation he had acquired by his distant travels, and his being crowned at the Olympic games, produced the most astonishing effects in the morals and customs of the people. The young soon left the pursuits of pleasure and intemperance, became industrious, and paid that obedience to their parents, which the precepts of Pythagoras enjoined. The old were directed, no longer to spend their time in amassing money, or in canvassing for the fleeting honors of public offices, but to improve their understandings, and to seek that peace and those comforts of mind, which frugality, benevolence, and philanthropy alone can produce.

The precepts he delivered were enforced by his own examples. His artful measures rendered him an object not only of reverence, but of imitation. Those, who before thought any occupation, *but idleness*, beneath them, now felt a pride in imitating the great philosopher in various mechanical as well as other occupations; and declared that with industry they found *time to pass on agreeably*, and that they enjoyed a happiness they never knew before.

The great influence the philosopher possessed in his school was soon transferred to the world. His pupils divided with him the approbation and applause of his country. In a short time the rulers, legislators, and principal men of all the cities of Greece, Sicily, and Italy boasted in being the disciples of Pythagoras; and of having learned of him the great art of enjoying life rationally and of rendering their country happy.

In the great Universe he perceived regularity, correspondence, beauty, proportion, uniformity, and harmony as intentionally produced by the Creator. In his doctrines of morality, he discovered propensities in the human mind, which were common to the brute creation; but besides these, and the passions of ingratitude, avarice, and ambition, he perceived the nobler seeds of virtue; and supported, that the most ample and perfect happiness was to be found in the enjoyment of intellectual and moral pleasures.

His instructions to governments and to those concerned in the administration of the laws, were "never to suffer ingenuity and abilities to moulder away in obscurity, because these, when properly called forth, constituted the power, glory, and honour of the state."

From doctrines like these, delivered by a philosopher, who was *deified* by his countrymen, nothing but the most salutary consequences could arise. The truth of his maxims, respecting manufactures and commerce, has been amply illustrated by the immense wealth acquired by several nations of Europe, in consequence of their paying proper attention to them; and thereby creating a spirit of national industry, which increases with its wealth.

Apollonius of Pamphylia in Asia Minor, who flourished about 250 years B. C. is admitted by historians to be the inventor of CONIC SECTIONS. These are mathematical figures, by whose known and corresponding properties, geometrical propositions are demonstrated, and the laws of motion rendered intelligible and certain. Within the last century, their use has been rendered conspicuous by several eminent mathematicians of Europe, particularly by Sir Isaac Newton, in his correct calculations of the revolution, of the planets belonging to the solar system.

These figures are five in number, viz. the triangle, the circle, the ellipse, the parabola, and the hyperbola ; the three latter are purely conic sections; the two former, though belonging to conic sections, may be produced as correctly without the assistance of a cone. The use of the triangle and circle in surveying, navigation, gunnery &c, is well known. The ellipse and hyperbola, in connection with the other figures, contain the data or known principles, by which the periods of the planets are calculated with accuracy, as they are known to be governed by those laws of motion, as demonstrated by the properties of these figures. The parabola is a figure, upon which the science of gunnery is founded. The random or range of a ball or shell of a given weight thrown with a given quantity of proof-powder, will be in proportion to the elevation of the piece. The proper elevation of a mortar is at 45 degrees for throwing shells at the greatest distance and with the greatest accuracy. If the height to which the shell rises is exactly half the distance, at which the shell is to be thrown, the engineer is then sure of hitting his mark. In this art practice must always be joined with theory, in order to produce a skilful gunner or engineer.

The demonstration of every proposition in geometry depends upon the known properties of these figures, which are formed by cutting a perfect cone in different directions, according to the nature of the figure to be produced.

To Archimedes a famous geometrician of Syracuse in the island of Sicily, who flourished about 212 years B. C. the world is indebted for the discovery of a certain and easy method of determining the pureness of gold or silver, by weighing the same in water. This invention now constitutes the science of hydrostatics. By knowing the weight of pure gold when immersed in water, and also that of copper, which is used as the alloy, it will be easy to determine the quantity of alloy that may be mixed with the gold. Besides this, Archimedes made many more important discoveries, such as burning glasses, which he so constructed as to set the enemy's fleet on fire at a considerable distance. He contrived engines, with which he destroyed the Roman ships, as they lay by the walls of his city. And it was by his inventions of machines of defence, and of plans of annoying the enemy, that the city of Syracuse was enabled to hold out a three-years-siege against a powerful Roman army, under the command of that great general, Marcellus, who acknowledged himself to have been more annoyed and retarded in his operations against that place, by the numerous and unexpected plans of defence, which the inventions of *that* Archimedes continually played off

against his army, than from the bravery or discipline of the Syracusians.

Such were the advantages, according to historians, derived from the inventions of an individual, whom his country employed in their defence solely on account of his inventive genius, which was always ready to meet any emergency with new and adequate measures, to the surprise and defeat of the enemy.—With some of his engines, large timbers were thrown with great force, which beat down whole companies of the enemy, and obliged them to retire, and keep at a distance from the city.—Ancient history does not furnish a single instance, wherein the mechanical ingenuity, and the ready invention of any man, was ever employed to so great advantage.

(To be continued.)

ON TRISECTION OF ANGLES.

MESSRS. EDITORS,

THE utility of a correct method of trisecting any angle, capable of geometrical demonstration, has induced your correspondent to spend some leisure hours in studying this proposition. In this investigation it early occurred, that trisection alone would not complete the division of the geometric circle to single parts corresponding to the degrees used in surveying; this subject, of course, excited considerable attention, and the consideration of a proposition fot *quinsecting* any angle, may furnish matter for some future number.

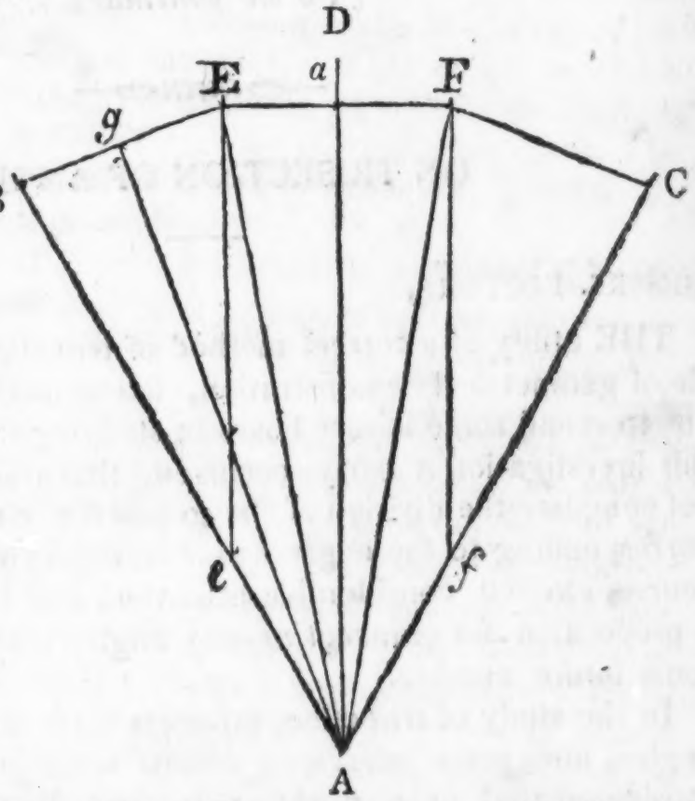
In the study of trisection, attempts were first made on obtuse angles, and, some interesting results were produced, but it was considered that as a *right* angle may be trisected by similar equilateral triangles, erected within each leg, so if any *acute* angle could be trisected, it would enable the trisection of any angle, as the right angle being cut off from any obtuse angle and trisected, the remaining part being acute and trisected, one part of each taken together, would make a third of the whole.

This course of study on acute angles produced the following Proposition, which will apply to all angles, and is submitted for publication by your reader—— a. b. c.

j. o.

Prop. Theorem.

If in any angle a bisecting line be drawn, and a parallel to the bisecting line be drawn on one side thereof; and another parallel to the bisecting line be drawn, at equal distance therefrom, on the other side thereof; and a line be drawn from one of the parallels to the leg of the angle on the same side of the bisecting line, equal to the distance of the parallels one from the other, and so as to be at right angles with a line drawn from its center to the angular point; and a line be drawn at right angles with the bisecting line, from the point in that parallel where the line from the leg to the parallel terminates, to the other parallel; from those points in the parallels, lines drawn to the angular point, will trisect the angle.



In the angle B A C, let D A, be the bisecting line, E e, and F f, parallels at equal distance from the bisecting line; let B E be equal to the nearest distance between the parallels E e, F f, and at right angles with a line drawn from the center of B E to A; and E F at right angles with DA from the point E of the line BE; then from the points E and F in the parallels, the lines E A—F A will trisect the angle.

From the center of B E, at right angles draw g A. then &c.

N. B. The demonstration and observations following it, are reserved to appear entire in the next Number, as part appearing on this page would excite confusion.

Note—In some of the impressions of this number in page 63 the given line is marked E E, which should be E F, and in page 64 line 12 from the top for equal to E E, read equal to E F.